Indicator: Ambient Concentrations of Lead (005)

Lead is a naturally occurring metal that is found in the Earth's crust and in various manufactured products, such as batteries and metal alloys. Some chemicals containing lead were previously added to gasoline to enhance vehicle performance, but that practice was phased out during the 1970s and 1980s. As a result, air emissions of lead from the transportation sector decreased dramatically during that period (see Indicator "Lead Emissions"). Today, the highest levels of airborne lead are usually found near industrial operations that process materials containing lead, such as smelters and battery manufacturers (EPA, 2003).

Despite reduced emissions, lead remains an important environmental health issue because excessive exposure can cause serious health effects, including neurological impairments such as seizures, mental retardation, and behavioral disorders (EPA, 1986). Even at low doses, lead exposure can cause damage to the nervous systems of fetuses and young children (see Indicator "Blood Lead Level"). Lead exposure can occur by inhalation of airborne particles that contain lead, drinking contaminated water, eating contaminated food items, or by ingesting non-food items that contain lead, such as dust and paint chips.

This indicator reflects ambient lead concentrations in $\mu g/m^3$ from 1980 to 2003. Trends for this indicator are based on measurements made at the 20 monitoring stations in the National Air Monitoring Stations (NAMS) and State and Local Air Monitoring Stations (SLAMS) network that have consistently measured ambient air concentrations of lead over the entire time frame of interest. Reported values are annual maximum quarterly averages.

What the Data Show

Figure 005-1 shows how lead concentrations have changed in the United States over the last 25 years. Between 1980 and 2004, the average lead concentrations decreased 98%. This decrease, which occurred mostly during the 1980s and early 1990s, is largely attributed to reduced lead content in gasoline (Latest Findings on National Air Quality, EPA 454/K-03-001,2003). In 2003, ambient air concentrations of lead exceeded EPA's health-based air quality standards in only two counties nationwide (US EPA Green Book, http://www.epa.gov/oar/oaqps/greenbk/lindex.html).

Indicator Limitations

- Ambient monitoring for lead occurs mostly in urban areas and in areas with large industrial processes that emit lead. Consequently, the average concentrations shown here might not be representative of average concentrations in rural areas.

Data Sources

U.S. Environmental Protection Agency. Air Quality System (http://www.epa.gov/air/data/index.html)

References

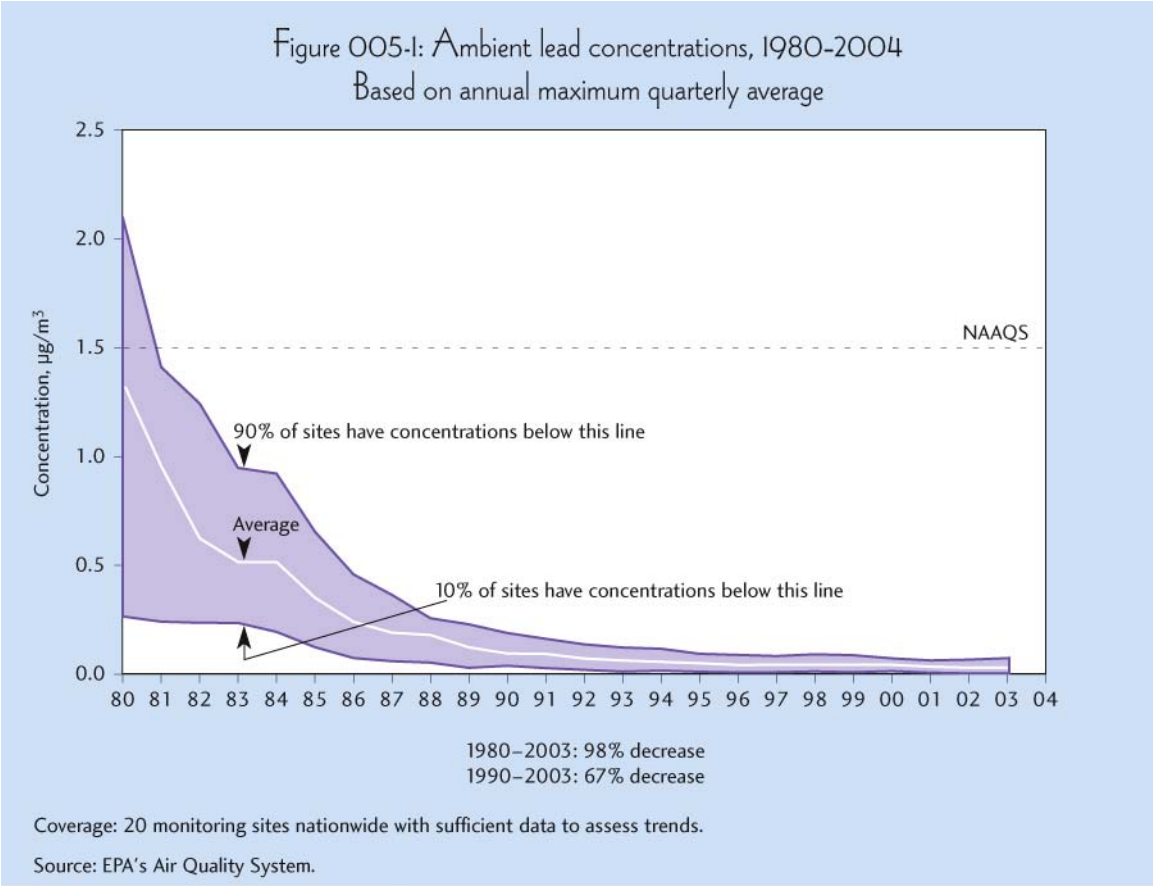
U.S. Environmental Protection Agency. Latest Findings on National Air Quality – 2002 Status and Trends, EPA 454/K-03-001. Research Triangle Park, NC; US Environmental Protection Agency, Office of Air Quality Planning and Standards, August 2003.

U.S. Environmental Protection Agency. Air Quality Criteria for Lead, EPA/600/8-83/028 aF-dF. Research Triangle Park, NC; U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment, 1986.

U.S. Environmental Protection Agency. National Air Quality and Emissions Trends Report - 2003 Special Studies Edition, EPA 454/R-03-005. Research Triangle Park, NC: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, September 2003.

U.S. Environmental Protection Agency. Green Book - http://www.epa.gov/oar/oaqps/greenbk/lindex.html

Graphics



Note: Figure will be updated with 2004 data, once the data are available.

R.O.E. Indicator QA/QC

Data Set Name: AMBIENT LEAD CONCENTRATIONS
Indicator Number: 005 (89070)
Data Set Source: EPA Air Quality System
Data Collection Date: ongoing: since at least 1980-present
Data Collection Frequency: Varies. See 40 CFR Parts 53 & 58 & attached QA/QC
Data Set Description: Ambient Lead Concentrations
Primary ROE Question: What are the trends in outdoor air quality and effects on human health and ecological systems?

Question/Response

T1Q1 Are the physical, chemical, or biological measurements upon which this indicator is based widely accepted as scientifically and technically valid?

Yes. The ambient air quality data are based on data retrieved from the Air Quality System (AQS) in August 2004. These are direct measurements of pollutant concentrations at monitoring stations operated by tribes and state and local governments throughout the nation. The monitoring stations are generally located in larger urban areas. EPA and other federal agencies also operate some air quality monitoring sites on a temporary basis as a part of air pollution research studies. The national monitoring network conforms to uniform criteria for monitor siting, instrumentation, and quality assurance. The program under which the data are collected is the NAMS/SLAMS network. A description of this network includes: 1) 40 CFR 50 - National ambient air quality standards (NAAQS) and reference methods for determining criteria air pollutant concentrations in the atmosphere; 2) 40 CFR 53 - Process for determining reference or equivalent methods for determining criteria air pollutant concentrations in the atmosphere; 3) 40 CFR 58 - Ambient air quality surveillance (monitoring) requirements. These methods and requirements can be found at http://www.epa.gov/ttn/amtic/. The Lead Manual Reference Method can be found in 40 CFR Part 50, Appendix G - Reference Method for the Determination of Lead in Suspended Particulate Matter Collected from Ambient Air. [Federal Register: Vol. 43, page 46258, 10/05/78]. These results have been peer reviewed. The most recent review was as a part of the National Air Quality and Emissions Trends Report, 2001 EPA 454/K-02-001, September 2002. This report is available at: http://www.epa.gov/airtrends.

T1Q2 Is the sampling design and/or monitoring plan used to collect the data over time and space based on sound scientific principles?

Yes. In 2003, thousands of monitoring sites reported air quality data for one or more of the six National Ambient Air Quality Standards (NAAQS) pollutants to AQS. The sites consist of National Air Monitoring Stations (NAMS), State and Local Air Monitoring Stations (SLAMS), and other special-purpose monitors. NAMS were established to ensure a long-term national network for urban area-oriented ambient monitoring and to provide a systematic, consistent database for air quality comparisons and trends analysis. SLAMS allow state or local governments to develop networks tailored for their

immediate monitoring needs. For this indicator, 39 ambient Pb monitors met the trends data completeness criteria for the period from 1982 to 2001, and 96 ambient Pb monitors met the trends data completeness criteria for the 10-year period from 1992 to 2001. Point-source-oriented monitoring data were omitted from all ambient trends analysis presented in this section to avoid masking the underlying urban trends.

T1Q3 Is the conceptual model used to transform these measurements into an indicator widely accepted as a scientifically sound representation of the phenomenon it indicates?

Yes. The conceptual model used to derive this indicators has been used and thoroughly reviewed as part of the Agency's national report on air quality trends for 25 years. Lead air quality monitoring sites meet the annual trends data completeness requirement if they have at least 6 valid daily measurements for each calendar quarter. The model basically has three elements: 1) Determine if year is valid for inclusion. Must have greater than or equal to 6 valid daily measurements for each calendar quarter. 2) Determine if site is valid for trends. Must have greater than or equal to 75% of possible years in the time series. For the 24-year period 1980-2003, trend sites must have at least 18 valid years and must not be missing more than 2 consecutive years of data. 3) Interpolate for missing years. Simple linear interpolation is used to fill in for missing years in the following way. Missing annual summary statistics for the in-between years for a site are estimated by linear interpolation from the surrounding years. Missing end points are replaced with the nearest valid year of data. The resulting data sets are statistically balanced, allowing simple statistical procedures and graphics to be easily applied. This procedure is conservative since endpoint rates of change are dampened by the interpolated estimates. References include: U.S. Environmental Protection Agency. Latest Findings on National Air Quality - 2002 Status and Trends, 2003, EPA 454/K-03-001. Research Triangle Park, NC; US Environmental Protection Agency, Office of Air Quality Planning and Standards, August 2003.

T2Q1 To what extent is the indicator sampling design and monitoring plan appropriate for answering the relevant question in the ROE?

Lead is one of six primary air pollutants controlled by the Clean Air Act Amendments of 2005, and so is important in answering the question, "What are the trends in air quality and its effects on human health and the environment?" The national air monitoring network for the six criteria air pollutants is extensive; however, there are far more monitors in urban areas than in rural areas. Point-source-oriented monitoring data were omitted from all ambient trends analysis presented in this section to avoid masking the underlying urban trends. EPA is currently conducting a national assessment of the existing ambient monitoring networks and is analyzing, among other issues, the need for and appropriateness of each of the nation's urban monitors.

T2Q2 To what extent does the sampling design represent sensitive populations or ecosystems?

The existing monitoring network captures sensitive populations. The national monitoring network is extensive. As noted in Question T2Q1, there are far more monitors in urban

areas than in rural areas. Population tends to be concentrated in urban areas. Consequently, these urban areas are more likely to contain populations that are particularly sensitive to lead. EPA uses various tools and techniques (e.g., models and spatial analyses) to augment the limited monitoring in rural areas. These tools help EPA better characterize pressures on ecological condition.

T2Q3 Are there established reference points, thresholds or ranges of values for this indicator that unambiguously reflect the state of the environment?

Yes, the level of the corresponding national ambient air quality standard (NAAQS) for lead is 1.5 ug/m3. This level is indicative of the state of the environment with respect to ambient air concentrations of lead.

T3Q1 What documentation clearly and completely describes the underlying sampling and analytical procedures used?

National Air Quality and Emissions Trends Report, 2003 Special Studies Edition - http://www.epa.gov/air/airtrends/aqtrnd03/. General Air Quality and National Monitoring Network - http://www.epa.gov/ttn/amtic/criteria.html.

T3Q2 Is the complete data set accessible, including metadata, data-dictionaries and embedded definitions or are there confidentiality issues that may limit accessibility to the complete data set?

Yes. The data used to develop these indicators are available through the Air Quality Subsystem of the Aerometric Information Retrieval System (AIRS). Information on AIRS can be obtained at: http://www.epa.gov/ttn/airs/. In addition, data from AIRS can be accessed via the Internet at: http://www.epa.gov/air/data/index.html.

T3Q3 Are the descriptions of the study or survey design clear, complete and sufficient to enable the study or survey to be reproduced?

Yes, The Ambient Monitoring Technology Information Center (AMTIC) contains information and files on ambient air quality monitoring programs, details on monitoring methods, relevant documents and articles, information on air quality trends and nonattainment areas, and federal regulations related to ambient air quality monitoring. This information can be found at http://www.epa.gov/ttn/amtic/criteria.html.

T3Q4 To what extent are the procedures for quality assurance and quality control of the data documented and accessible?

The QA/QC of the national air monitoring program has several major components: the Data Quality Objective (DQO) process, reference and equivalent methods program, EPA's National Performance Audit Program (NPAP), system audits, and network reviews (Available on the Internet: www.epa.gov/ttn/amtic/npaplist.html). To ensure quality data, the SLAMS are required to meet the following: 1) each site must meet

network design and site criteria; 2) each site must provide adequate QA assessment, control, and corrective action functions according to minimum program requirements; 3) all sampling methods and equipment must meet EPA reference or equivalent requirements; 4) acceptable data validation and record keeping procedures must be followed; and 5) data from SLAMS must be summarized and reported annually to EPA. Finally, there are system audits that regularly review the overall air quality data collection activity for any needed changes or corrections. Further information available on the Internet (http://www.epa.gov/cludygxb/programs/namslam.html) and through United States EPA's Quality Assurance Handbook (EPA-454/R-98-004 Section 15). There is a Quality Assurance Project Plan from each state or local agency operating a NAMS/SLAMS monitor meeting the AEPA Requirements for Quality Assurance Project Plans, EPA QA/R-5. The quality assurance plans for specific sites are publicly available by request to the reporting agency or the corresponding EPA Regional Office. The plans are audited at least once every three years as required in 40 CFR 58, Appendix A, Section 2.5. In addition, the data repository itself (i.e. AQS) provides direct access to two of the more prominent quality assurance indicators (i.e., precision and accuracy).

T4Q1 Have appropriate statistical methods been used to generalize or portray data beyond the time or spatial locations where measurements were made (e.g., statistical survey inference, no generalization is possible)?

Yes, The air quality statistics presented relate to the pollutant specific NAAQS and comply with the recommendations of the Intra-Agency Task Force on Air Quality Indicators. A composite average of each trend statistic is used in the graphical presentations. All sites were weighted equally in calculating the composite average trend statistic. Missing annual summary statistics for the second through ninth years for a site are estimated by linear interpolation from the surrounding years. Missing end points are replaced with the nearest valid year of data. The resulting data sets are statistically balanced, allowing simple statistical procedures and graphics to be easily applied. This procedure is conservative since endpoint rates of change are dampened by the interpolated estimates. The statistic used to track ambient lead air quality is the maximum quarterly mean concentration for each year. From 1982 to 2001, a total of 39 ambient Pb monitors met the trends data completeness criteria, and a total of 96 ambient Pb monitors met the trends data completeness criteria for the 10-year period from 1992 to 2001. Point-source-oriented monitoring data were omitted from all ambient trends analysis presented in this section to avoid masking the underlying urban trends.

T4Q2 Are uncertainty measurements or estimates available for the indicator and/or the underlying data set?

Yes. The data repository itself (i.e. AQS) provides direct access to two of the more prominent quality assurance indicators (i.e., precision and accuracy).

T4Q3 Do the uncertainty and variability impact the conclusions that can be inferred from the data and the utility of the indicator?

No, We are not aware of any sources of error that may affect the findings developed from these data.

T4Q4 Are there limitations, or gaps in the data that may mislead a user about fundamental trends in the indicator over space or time period for which data are available?

The national air monitoring network for the six criteria air pollutants is extensive; however, there are far more monitors in urban areas than in rural areas. Monitoring in urban areas helps to characterize population exposures, because population tends to be concentrated in urban areas. For this indicator, only 39 ambient Pb monitors met the trends data completeness criteria for the period from 1982 to 2001, and 96 ambient Pb monitors met the trends data completeness criteria for the 10-year period from 1992 to 2001, so this might not be widely representative of the nation as a whole. Point-source-oriented monitoring data were omitted from all ambient trends analysis presented in this section to avoid masking the underlying urban trends.